Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

IV SEMESTER B.TECH. (AERONAUTICAL ENGINEERING)

END SEMESTER EXAMINATIONS, APRIL 2017

SUBJECT: FLIGHT MECHANICS [AAE 2203]

REVISED CREDIT SYSTEM
(26/04/2017)

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

1A. Discuss the vertical structure of the atmosphere and its various layers through a diagram. **(3)**

1B. Define induced drag and show that slope of the lift curve for a finite wing is less than that for an infinite wing. **(3)**

1C. Consider a finite wing with an aspect ratio of 7; the airfoil section of the wing is a symmetrical airfoil with an infinite wing lift slope of 0.11 per degree. The lift to drag ratio for this wing is 29 when the lift coefficient is equal to 0.35. If the angle of attack remains the same and the aspect ratio is simply increased to 10 by adding extensions to the span of the wing, what is the new value of the lift to drag ratio? Assume span efficiency factor e=0.9 for both the cases. **(4)**

2A. Derive an expression for the speed of an aircraft at which drag acting on the aircraft is minimum. **(3)**

2B. An airplane weighing 60,330 N has a wing area of 64 m^2 and is equipped with an engine-propeller combination which develops 500 KW of THP at 180 kmph under standard sea-level conditions. Calculate the rate of climb at this flight speed. The drag polar is given in the table below. **(4)**

C_L	0.0	0.1	0.2	0.3	0.4	0.5	0.6
C_D	0.022	0.0225	0.024	0.026	0.030	0.034	0.040

C_L	0.7	0.8	0.9	1.0	1.2
C_D	0.047	0.055	0.063	0.075	0.116

2C. An airplane stalls at M=0.2 at sea level. What will be the Mach number and equivalent airspeed when it stalls at 5 km altitude? Compare the thrust required to maintain level flight near stall at the two altitudes. Assume the weight of the airplane to be same at the two altitudes **(3)**

3A. Show that in an accelerated climb, the rate of climb will be lower than in a steady climb. **(3)**

3B. Derive an expression for the time taken and distance covered in an accelerated level flight. **(3)**

3C. An aircraft has a weight of 44482.21 N, a wing area of 18.58 m^2 and a parabolic drag curve $C_D=0.02+0.05C_L^2$, gliding from 6096 m to sea level. Compare the range and endurance for a maximum range flight condition with that for a maximum endurance flight condition. Given ρ_{6096m} = 0.905 kg/m^3 **(4)**

4A. Describe the equations of motion of an aircraft undergoing coordinated level turn and derive an expression for radius of turn with the help of a neat diagram. **(3)**

4B. An airplane with a wing area of 20 m^2 and a weight of 19,620 N dives with engine switched off, along a straight line inclined at 60^o to the horizontal. What is the acceleration of the airplane when the flight speed is 250 kmph? If the airplane has to pull out of this dive at a radius of 200 m, what will be the lift coefficient required and the load factor? Drag polar is given by: $C_D = 0.035 + 0.076C_L^2$ and the maneuver takes place around an altitude of 2 km. **(3)**

4C. Find the time to climb from sea level to an altitude of 6096 m using "Maximum R/C schedule". The aircraft parameters are, W= 44482.21 N, $C_D=0.02+0.05\ C_L^2$, S=18.58 m^2 and the thrust = 8896.44 N at sea level. Take ρ= 1.225 kg/m^3 at Sea level and ρ= 0.6529 kg/m^3 at 6096 m. **(4)**

5A. Explain the phases of takeoff with the help of a diagram and discuss how takeoff distances are estimated. **(3)**

5B. A jet airplane with a weight of 441, 450 N and wing area of 110 m^2 has a tricycle type landing gear. Its C_{Lmax} with flaps is 2.7. Obtain the take-off distance to 15 m screen height and the time taken for it. Given that: **(4)**

(i) $V_1 = 1.16\ V_{stall}$
(ii) $V_2 = 1.086\ V_1$
(iii) C_L during ground run is 1.15 & C_L during transition=1.605
(iv) Drag polar with landing gear and flaps deployed is $C_D = 0.044 +0.05C_L^2$
(vi) Thrust variation during take-off can be approximated as :
T = 128,500 – 0.0929 V^2; where V is in kmph and T is in Newton
(vii) Take off from a level, dry concrete runway (μ=0.02) at sea level.

5C. Explain any three high lift devices and their working principle with the help of neat sketches. **(3)**